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# Enhanced Echo Tops

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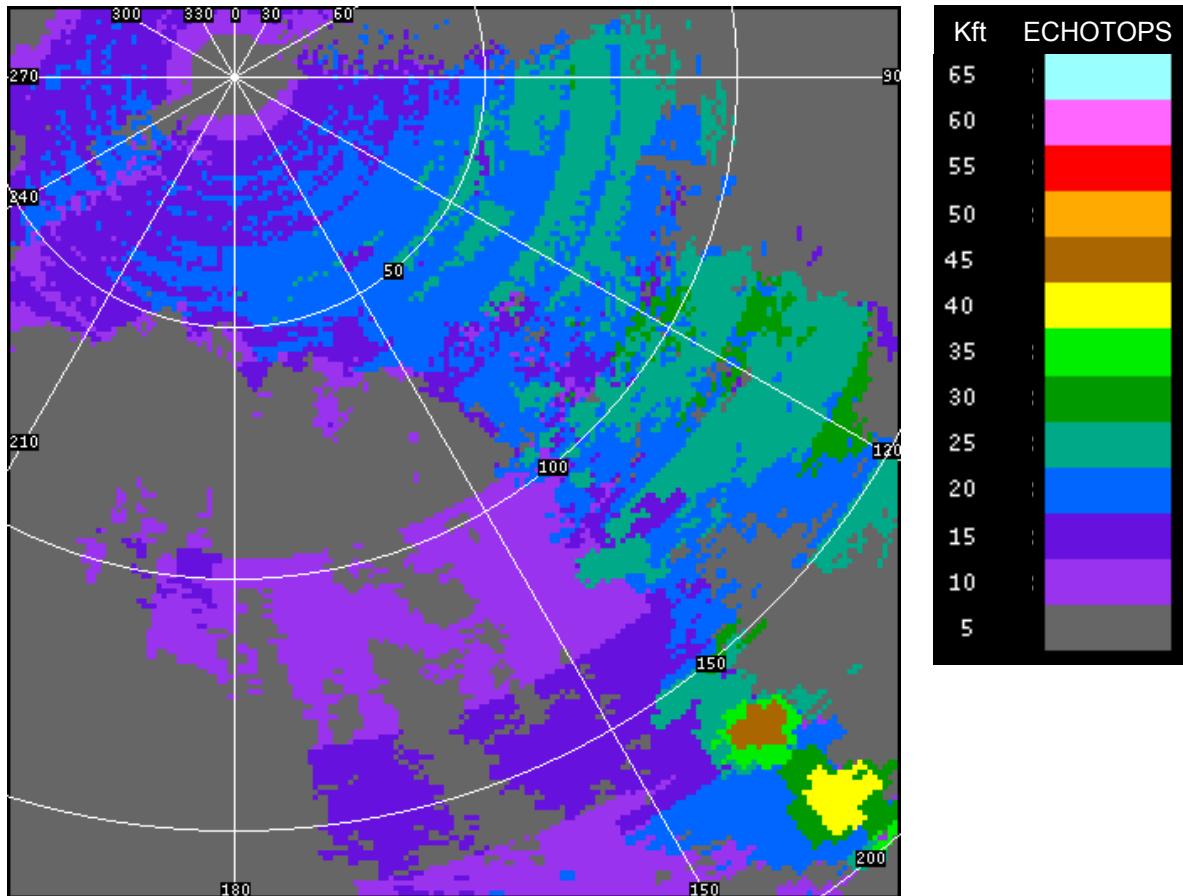
# Outline

- Current NEXRAD Echo Tops product
- Proposed Enhanced Echo Tops product
- Idealized example
- Real weather examples



# Example of NEXRAD Echo Tops Product

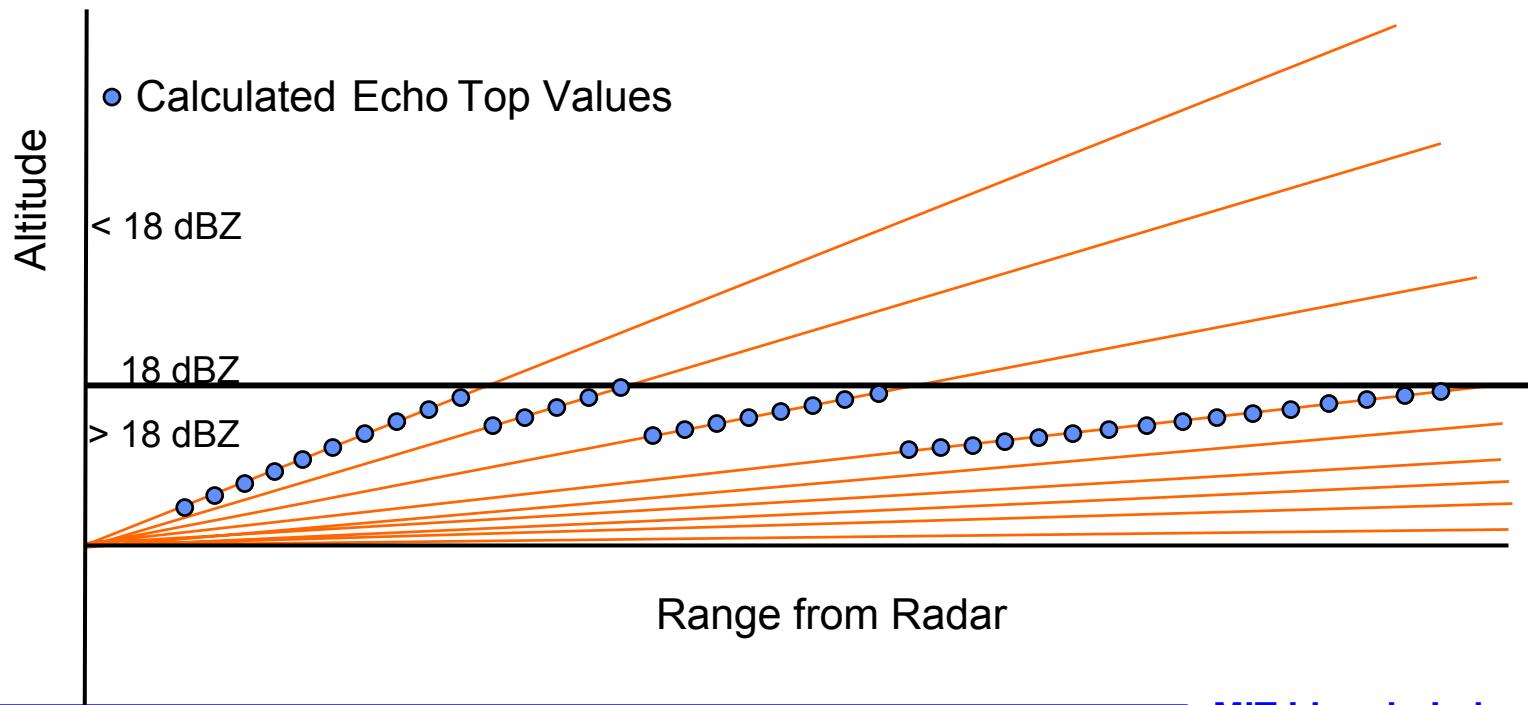
- **Resolution:** 4 km horizontal (Cartesian) x 5000 ft vertical
- **Ring-shaped artifacts present**





# Current Calculation of NEXRAD Echo Tops

- **Resolution:**
  - 4 km horizontal (Cartesian) x 5000 ft vertical
- **Computation of echo tops:**
  - Height of uppermost beam that equals or exceeds the chosen reflectivity level
  - Leads to “sawtooth” height estimates in range – ring artifacts





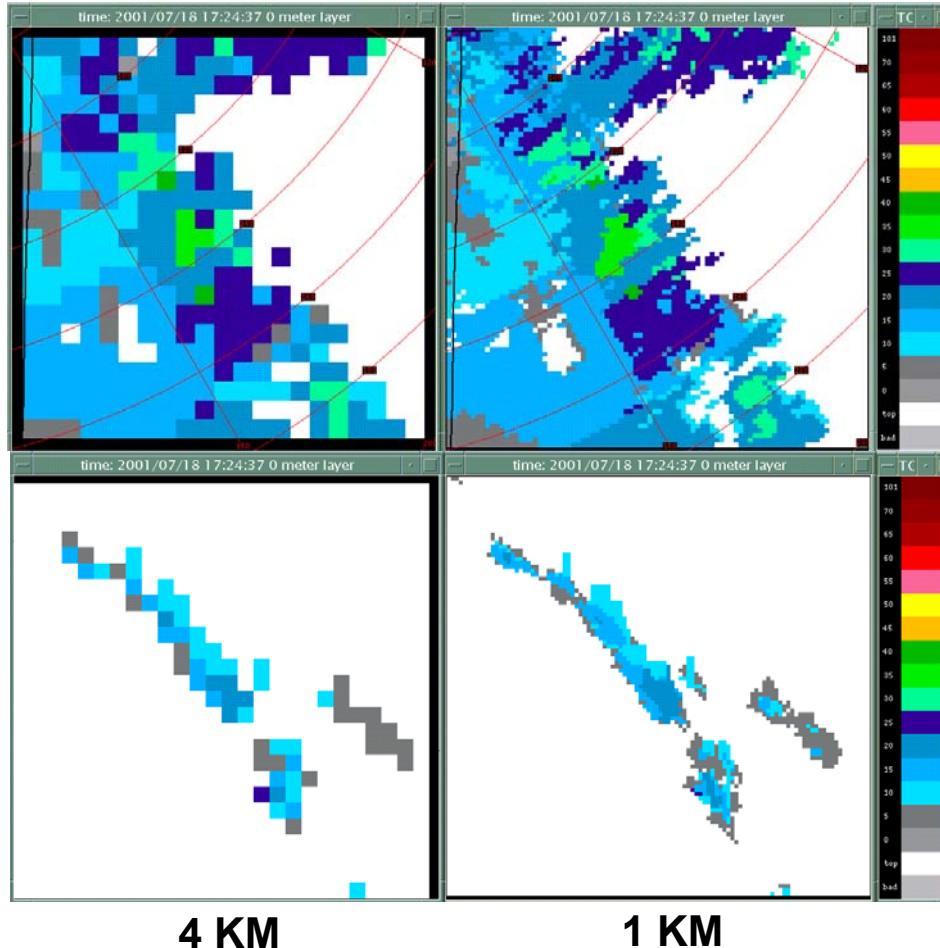
# Enhanced Echo Tops Algorithm

- **Motivation**
  - Echo tops levels and time trends are significant for aviation
  - Enroute aircraft often fly over storms
  - Aviation users (non-meteorological) interested in viewing echo tops maps
- **Horizontal resolution**
  - Polar representation
  - 1 deg azimuth x 1 km range out to 345 km max range
  - Permits users to determine preferred gridded resolution
- **Vertical quantization**
  - 1000 ft estimates of echo tops level
  - Matches new FAA Reduced Vertical Separation Minimums
- **Computation**
  - Uses vertical interpolation to better estimate tops height



# Examples of Increased Horizontal Resolution

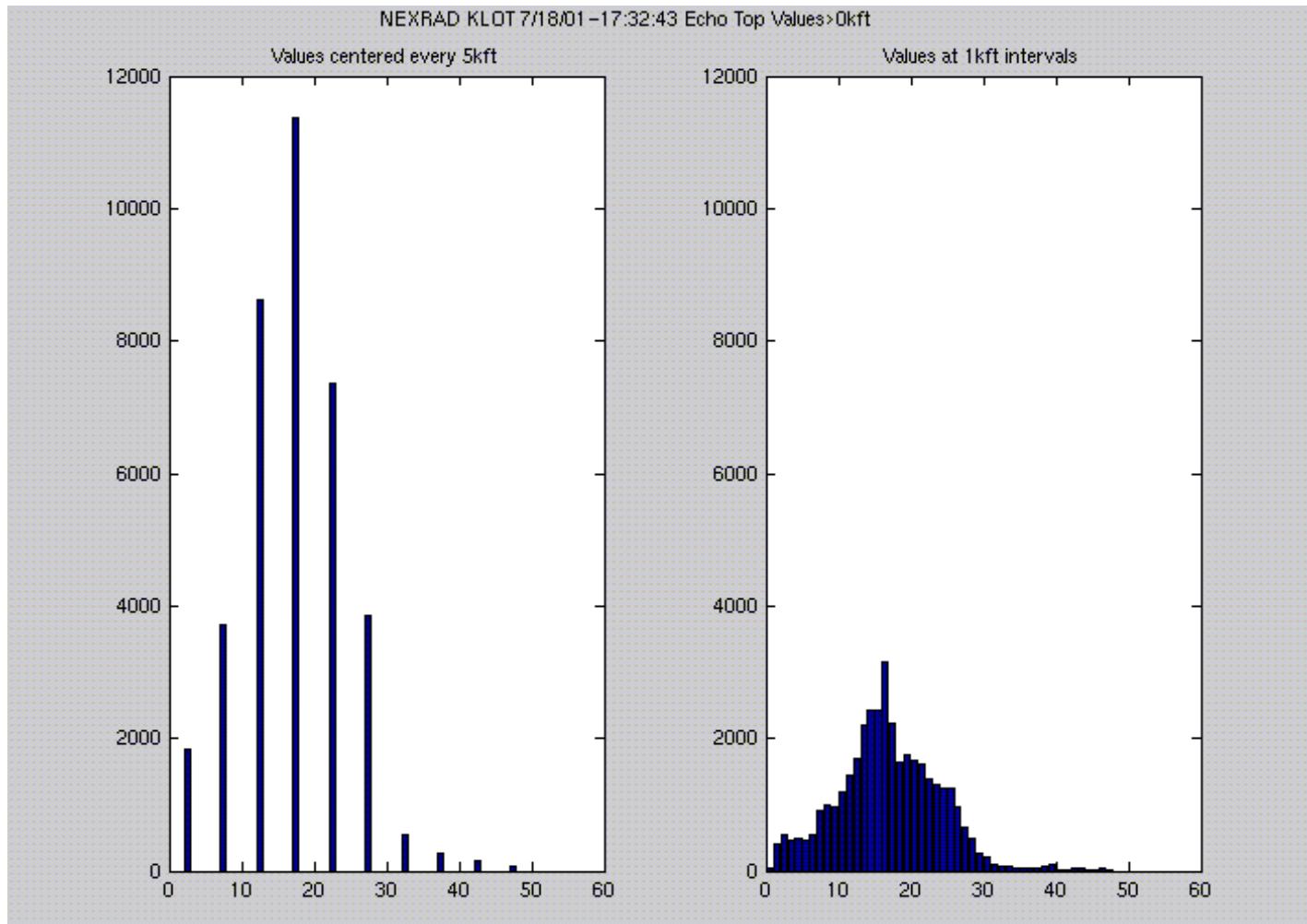
- Comparison of 4 km vs. 1 km horizontal resolution  
Used NEXRAD Echo Tops algorithm with 5000' bins





# Examples of Reduced Vertical Quantization

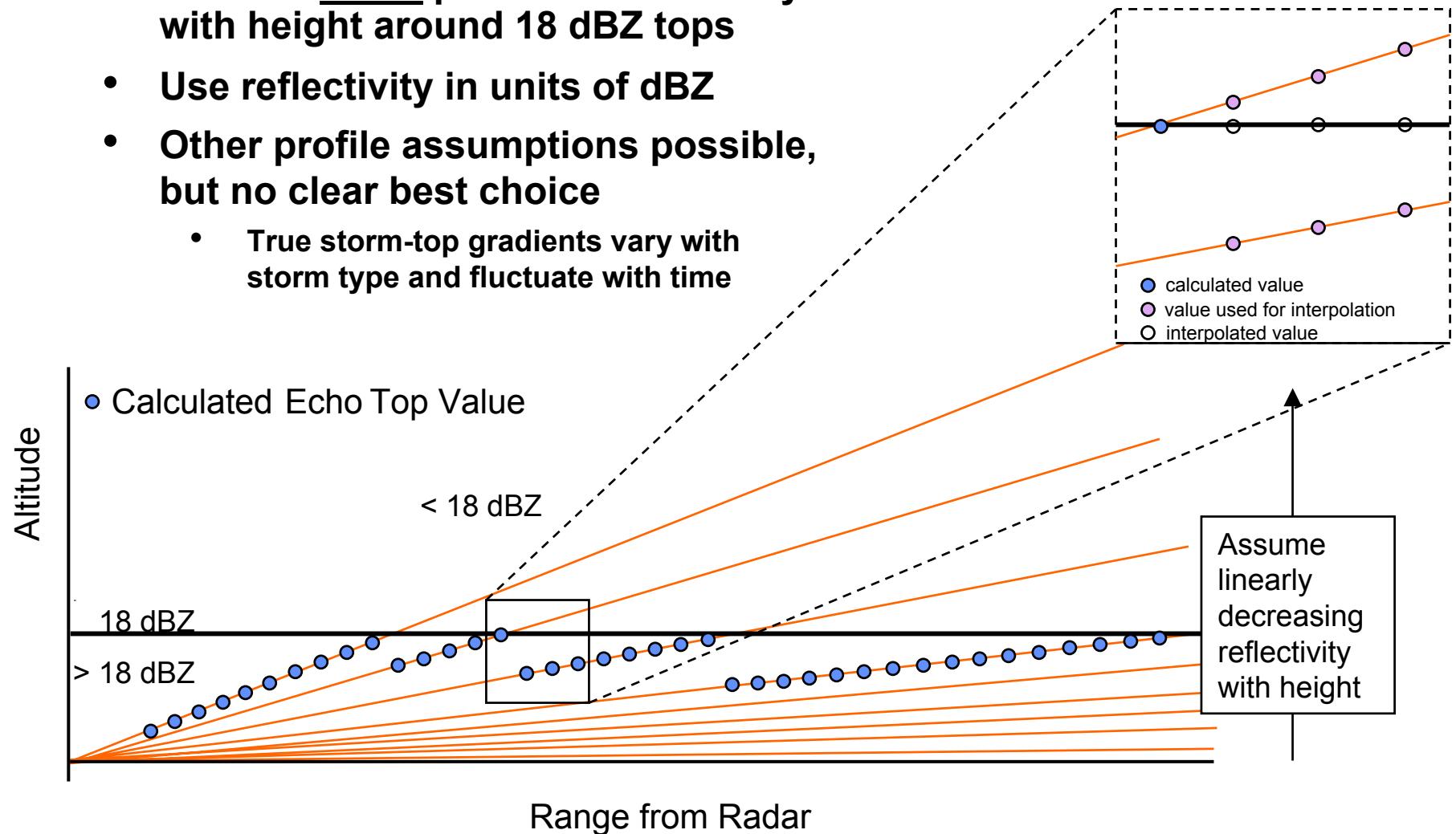
- Comparison of 5 Kft vs. 1 Kft height level quantization  
Used NEXRAD Echo Tops algorithm with 1 km horiz. res.





# Example of New Vertical Interpolation

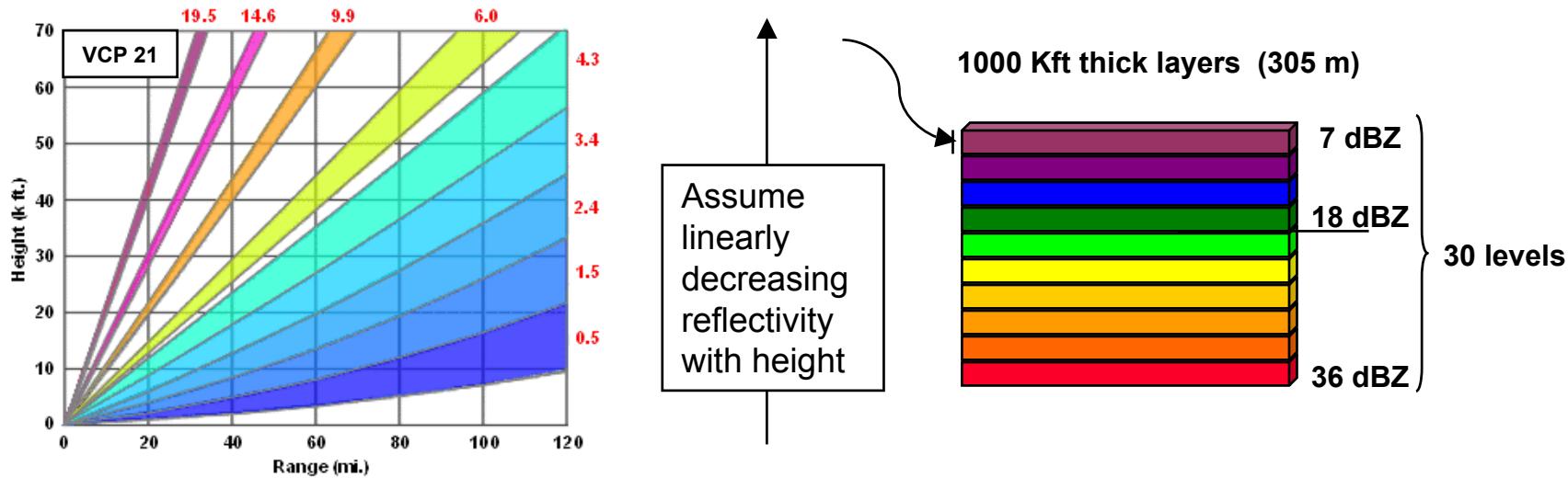
- Assume linear profile of reflectivity with height around 18 dBZ tops
- Use reflectivity in units of dBZ
- Other profile assumptions possible, but no clear best choice
  - True storm-top gradients vary with storm type and fluctuate with time





# Idealized Test of Interpolation Scheme

- Use idealized test case to determine effects of new interpolation
  - Cartesian data with 1 km horizontal x 500 m vertical resolution
  - Reflectivity layers linearly decreasing in dBZ value with height
  - Sampled with NEXRAD VCP 21 to create polar data

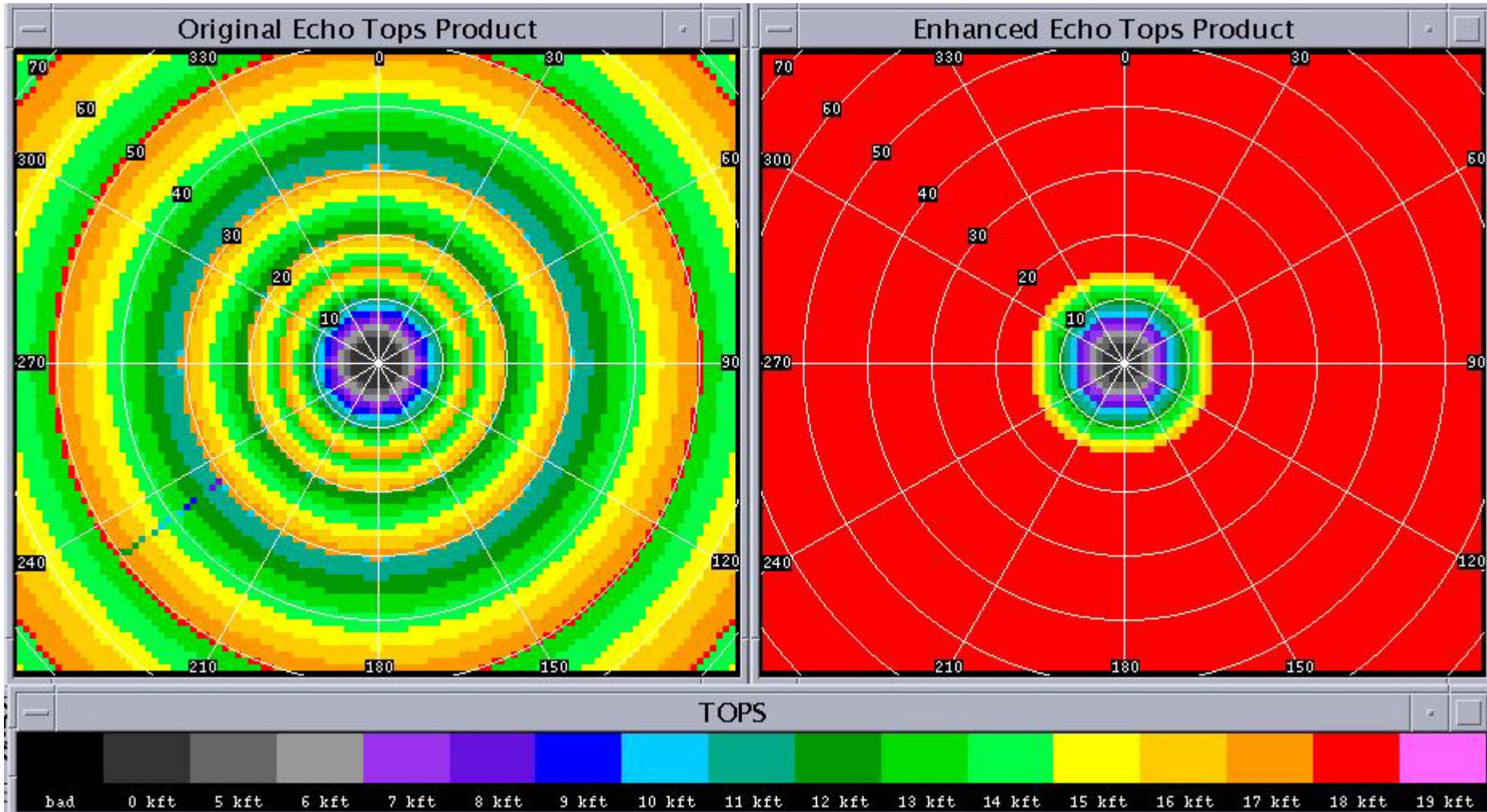


- Computed echo tops using 18 dBZ as chosen level
  - Original NEXRAD Echo Tops algorithm
  - New Enhanced Echo Tops algorithm



# Result of Interpolation on Idealized Case

- New interpolation reproduces flat echo top, except where “topped”

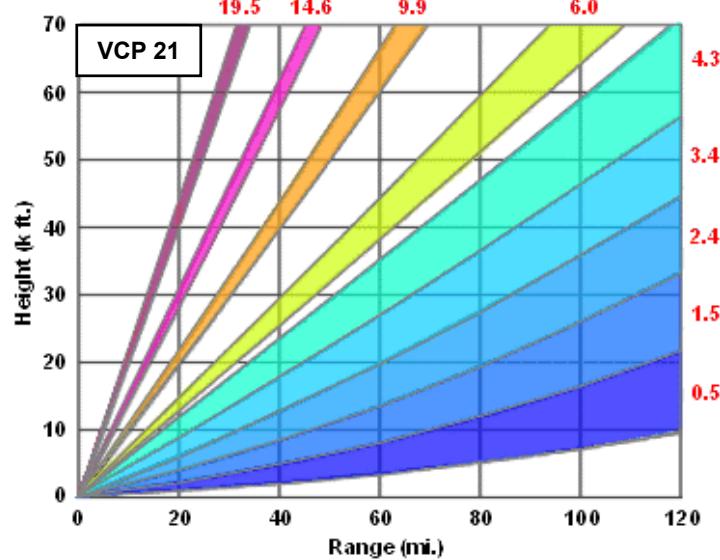
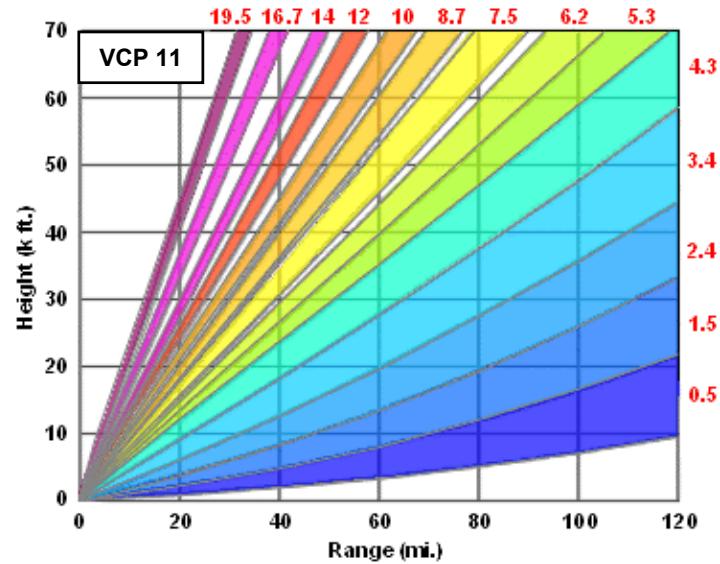


1000' color bins



# Real Weather Examples of EET

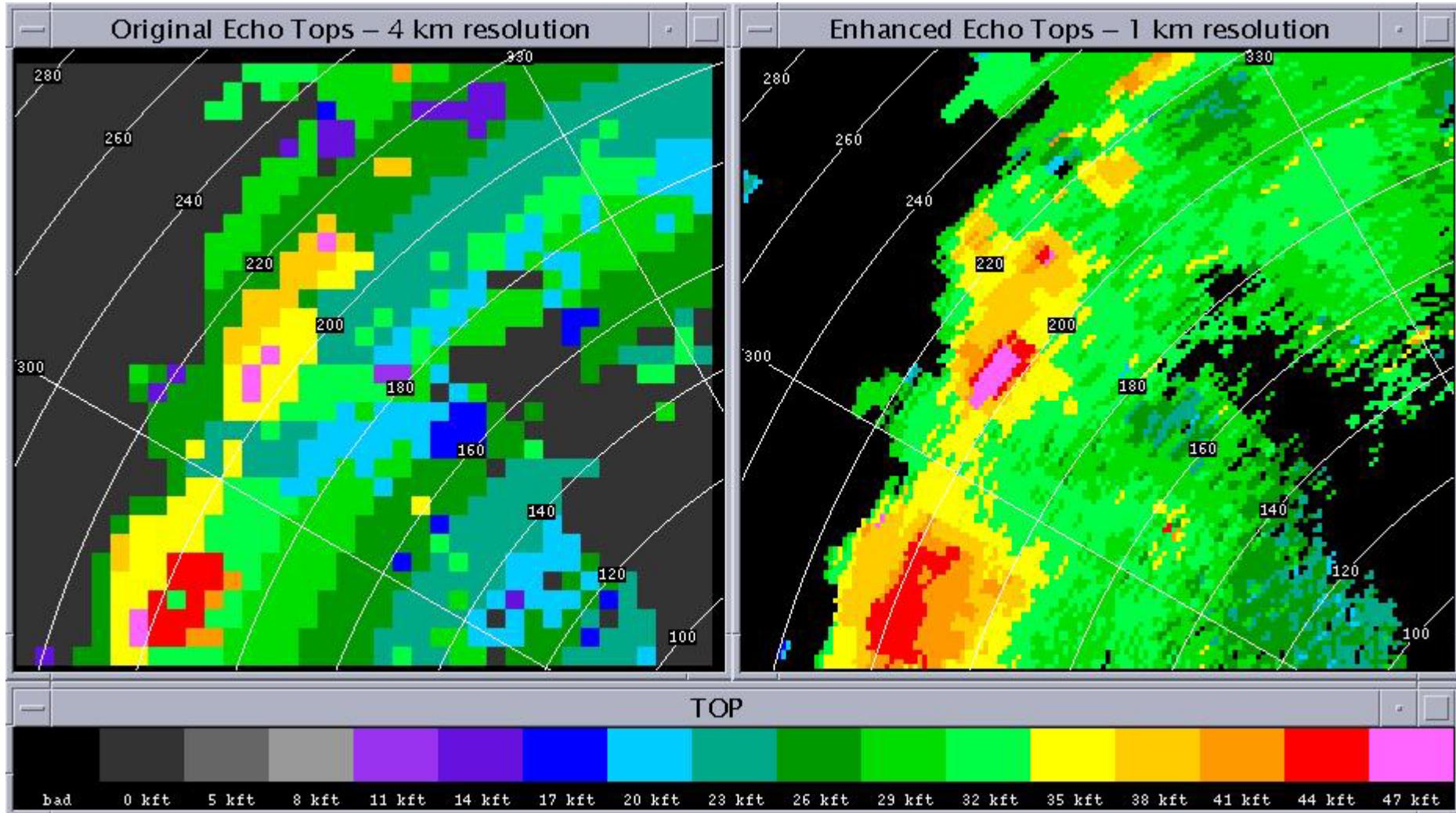
- Cellular convection
- Widespread winter storm





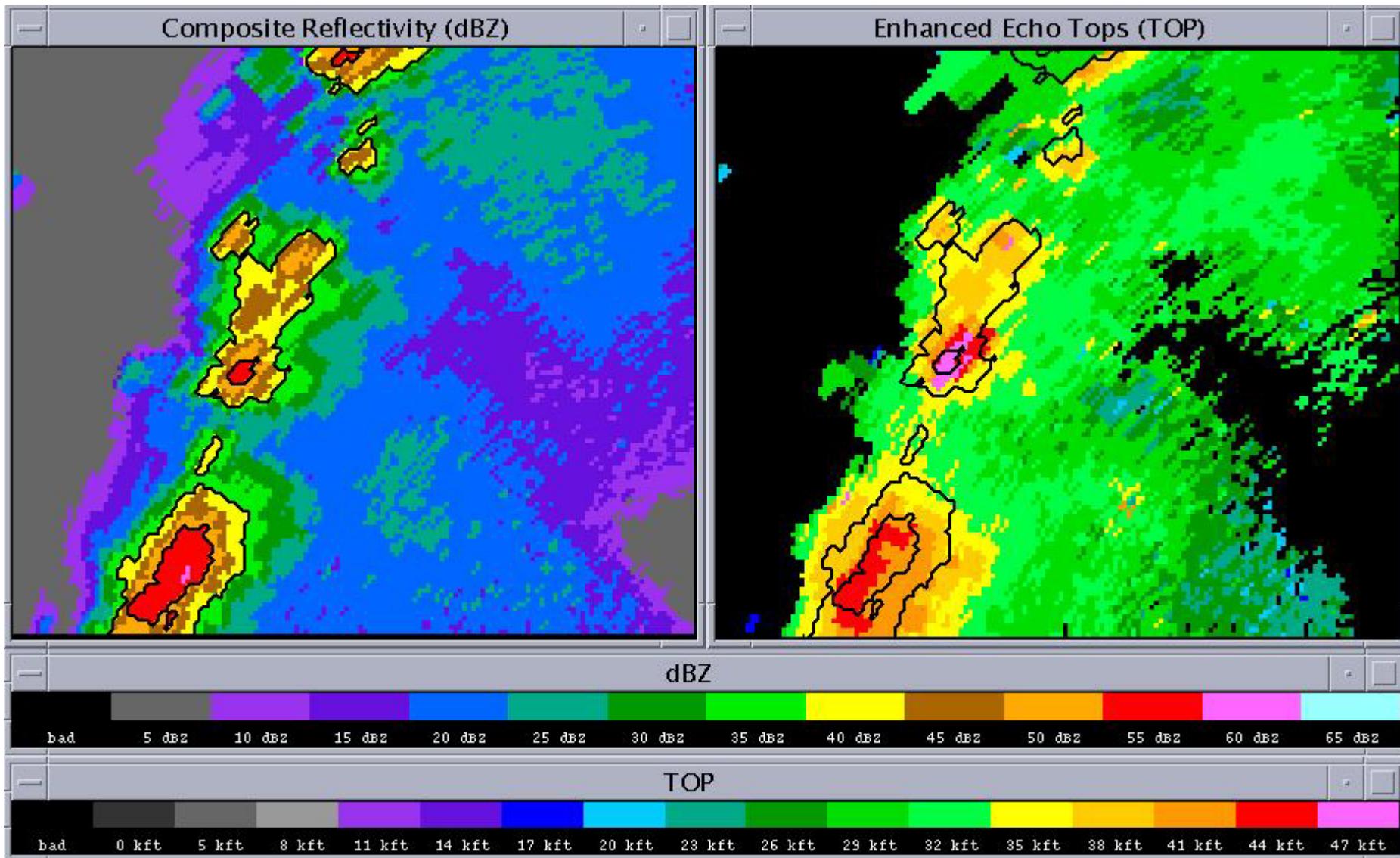
# Comparison of Computational Approaches

4 km vs 1 km with 3000' color bins



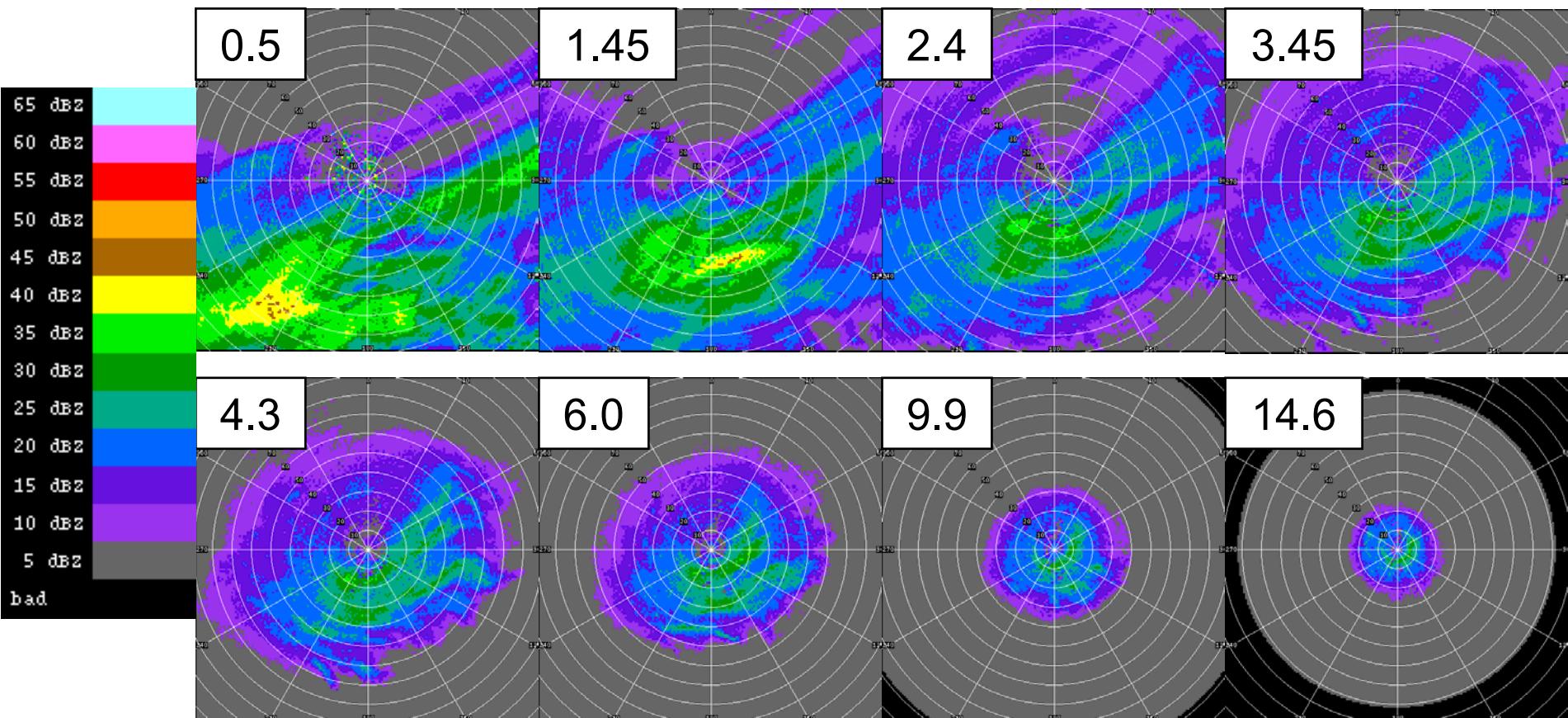


# Composite Reflectivity Relationship to EET





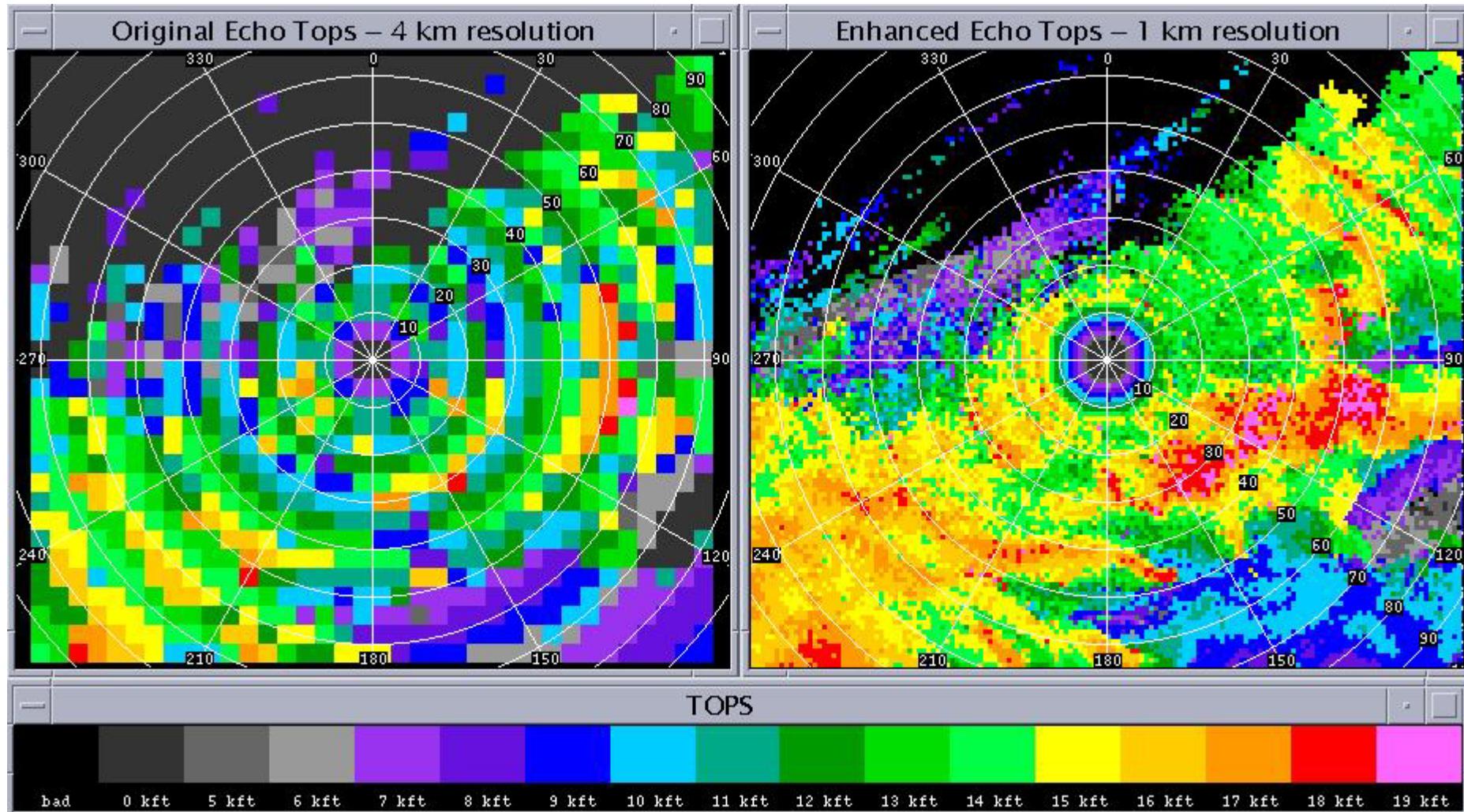
# Widespread Weak Winter Precip Case





# Comparison of Computational Approaches

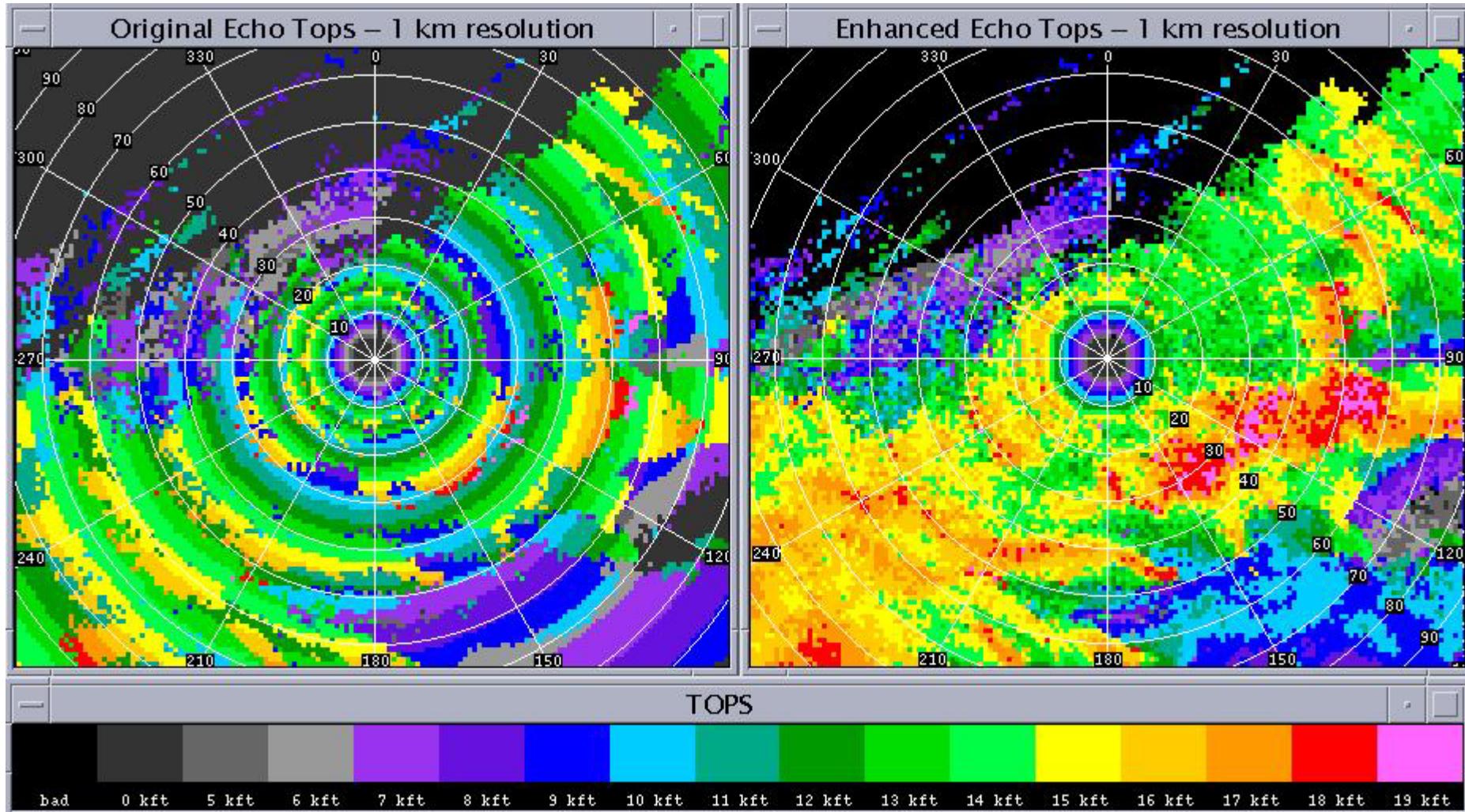
4 km vs. 1 km with 1000' color bins





# Comparison of Computational Approaches

1 km with 1000' color bins





# Summary

- Enhanced Echo Top algorithm will provide very useful product for aviation
  - Sawtooth and ring-shaped artifacts effectively mitigated
  - Resolution increased (both horizontal and vertical)
- Potential application in NWS and/or Air Force convective forecasting operations
- Work progressing on schedule for ORPG implementation
  - Build 4 implementation (September 2003)
  - Transfer to ROC in January 2003
- Remaining work involves:
  - Further testing with idealized “storms”
  - Testing on numerous weather radar cases
  - Hardening of code for ORPG